

WHAT IS CLAIMED IS:

1. An electrolyte membrane for a fuel cell, comprising:
a hydrated electrolyte layer containing moisture; and
5 dense layers made of a hydrogen permeable material and formed on both sides of the electrolyte layer.
2. The electrolyte membrane according to claim 1, wherein the hydrated electrolyte layer is a solid polymer membrane.
- 10 3. The electrolyte membrane according to claim 1, wherein the dense layer disposed at an oxygen electrode side of the fuel cell is formed from one of vanadium, niobium, tantalum, and an alloy containing at least a part of vanadium, niobium, and tantalum.
- 15 4. The electrolyte membrane according to claim 1, wherein the dense layer disposed at a hydrogen electrode side of the fuel cell is formed from one of palladium and a palladium alloy.
- 20 5. The electrolyte membrane according to claim 1, wherein the dense layer made of the hydrogen permeable material includes at least two hydrogen separation membrane layers respectively made of different kinds of metal, and a metal diffusion suppression layer, provided on at least a part of a contact interface between the separation membrane layers made of the different kinds of metal, for suppressing
25 diffusion of the different kinds of metal.
6. The electrolyte membrane according to claim 5, wherein the metal diffusion suppression layer includes at least one of a proton conductor, a mixed conductor, an insulating material, a ceramic, and a proton-nonconductive metal.
- 30 7. A fuel cell, comprising:
an electrolyte membrane having a hydrated electrolyte layer containing moisture, and dense layers, formed on both sides of the electrolyte layer and made of a hydrogen permeable material;

an oxygen electrode disposed on one side of the electrolyte membrane;

an oxidizing gas supply portion that supplies oxidizing gas to the oxygen electrode;

5 a hydrogen electrode disposed on the other side of the electrolyte membrane; and

a fuel gas supply portion that supplies a hydrogen-rich fuel gas to the hydrogen electrode.

10 8. The fuel cell according to claim 7, wherein the hydrated electrolyte layer is a solid polymer membrane.

9. The fuel cell according to claim 7, wherein the dense layer disposed at the oxygen electrode side of the fuel cell is formed from one of vanadium, niobium,
15 tantalum, and an alloy containing at least a part of vanadium, niobium, and tantalum.

10. The fuel cell according to claim 7, wherein the dense layer disposed at the hydrogen electrode side of the fuel cell is formed from one of palladium and a palladium alloy.

20 11. The fuel cell according to claim 7, wherein the dense layer made of the hydrogen permeable material includes at least two hydrogen separation membrane layers respectively made of different kinds of metal, and a metal diffusion suppression layer, provided on at least a part of a contact interface between the separation
25 membrane layers made of the different kinds of metal, for suppressing diffusion of the different kinds of metal.

12. The fuel cell according to claim 11, wherein the metal diffusion suppression layer includes at least one of a proton conductor, a mixed conductor, an
30 insulating material, a ceramic, and a proton-nonconductive metal.

13. An electrolyte membrane for a fuel cell, comprising:

a substrate formed from a dense hydrogen permeable material; and

an inorganic electrolyte layer formed on at least one side of the substrate.

5 14. The electrolyte membrane according to claim 13, wherein a surface of a side of the electrolyte layer that is not in contact with the substrate is coated with a coating made of a hydrogen permeable material.

10 15. The electrolyte membrane according to claim 14, wherein the substrate and the coating are formed from different kinds of metallic materials, respectively.

16. The electrolyte membrane according to claim 13, wherein the substrate made of the hydrogen permeable material includes at least two hydrogen separation membrane layers respectively made of different kinds of metal, and a metal diffusion suppression layer, provided on at least a part of a contact interface between the
15 separation membrane layers made of the different kinds of metal, for suppressing diffusion of the different kinds of metal.

17. The electrolyte membrane according to claim 16, wherein the metal diffusion suppression layer contains at least one of a proton conductor, a mixed
20 conductor, an insulating material, a ceramic, and a proton-nonconductive metal.

18. The electrolyte membrane according to claim 13, wherein the substrate is formed from one of vanadium, niobium, tantalum, and an alloy containing at least a part of vanadium, niobium, and tantalum.

25 19. The electrolyte membrane according to claim 13, wherein the electrolyte layer is formed from a solid oxide, and the electrolyte membrane has a reaction suppression layer, provided on at least a part of an interface between the substrate and the electrolyte layer, for suppressing a reaction between oxygen atoms, which are
30 contained in the electrolyte layer, and the substrate.

20. The electrolyte membrane according to claim 19, wherein the reaction suppression layer includes at least one of a proton conductor, a mixed conductor, and an insulating material.

21. The electrolyte membrane according to claim 13, wherein an electrolyte of the electrolyte layer is a composite oxide containing an A-site material having an alkali metal element as a principal component, and a B-site material having another element as a principal component, such that a molar ratio of the A-site material to the B-site material is constant, and also containing a predetermined amount of oxygen; the composite oxide is synthesized by a reaction between the A-site material and the B-site material, and during the reaction, a molar ratio of the A-site material to the B-site material is smaller than the constant molar ratio.

10

22. The electrolyte membrane according to claim 13, wherein an electrolyte of the electrolyte layer is a composite oxide containing an A-site material having an alkali metal element as a principal component, and a B-site material having another element as a principal component, such that a molar ratio of the A-site material to the B-site material is constant, and also containing a predetermined amount of oxygen; and the composite oxide is synthesized in a state in which the composite oxide contains a predetermined amount of an oxide of a third material that forms an oxide together with the alkali metal element.

20

23. A fuel cell, comprising:

an electrolyte membrane having a substrate formed from a dense hydrogen permeable material and an inorganic electrolyte layer formed on at least one side of the substrate;

an oxygen electrode disposed on one side of the electrolyte membrane;

an oxidizing gas supply portion that supplies an oxidizing gas to the oxygen electrode;

a hydrogen electrode disposed on the other side of the electrolyte membrane; and

a fuel gas supply portion that supplies a hydrogen-rich fuel gas to the hydrogen electrode.

30

24. The fuel cell according to claim 23, wherein a surface of a side of the electrolyte layer that is not in contact with the substrate is coated with a coating made of a hydrogen permeable material.

5 25. The fuel cell according to claim 24, wherein the substrate and the coating are formed from different kinds of metallic materials, respectively.

26. The fuel cell according to claim 23, wherein the substrate made of the hydrogen permeable material includes at least two hydrogen separation membrane
10 layers respectively made of different kinds of metal, and a metal diffusion suppression layer, provided on at least a part of a contact interface between the separation membrane layers of the different kinds of metal, for suppressing diffusion of the different kinds of metal.

15 27. The fuel cell according to claim 26, wherein the metal diffusion suppression layer contains at least one of a proton conductor, a mixed conductor, an insulating material, a ceramic, and a proton-nonconductive metal.

28. The fuel cell according to claim 23, wherein the substrate is formed from
20 one of vanadium, niobium, tantalum, and an alloy containing at least a part of vanadium, niobium, and tantalum.

29. The fuel cell according to claim 23, wherein the electrolyte layer is formed from a solid oxide, and the electrolyte membrane has a reaction suppression
25 layer, provided on at least a part of an interface between the substrate and the electrolyte layer, for suppressing a reaction between an oxygen atom, which is contained in the electrolyte layer, and the substrate.

30. The fuel cell according to claim 29, wherein the reaction suppression
30 layer contains at least one of a proton conductor, a mixed conductor, and an insulating material.

31. The fuel cell according to claim 23, wherein an electrolyte of the electrolyte layer is a composite oxide containing an A-site material having an alkali

metal element as a principal component, and a B-site material having another element as a principal component, such that a molar ratio of the A-site material to the B-site material is constant, and also containing a predetermined amount of oxygen; the composite oxide is synthesized by a reaction between the A-site material and the B-site material, and during the reaction, the molar ratio of the A-site material to the B-site material is smaller than the constant molar ratio.

32. The fuel cell according to claim 23, wherein an electrolyte of the electrolyte layer is a composite oxide containing an A-site material having an alkali metal element as a principal component, and a B-site material having another element as a principal component, such that a molar ratio of the A-site material to the B-site material is constant, and also containing a predetermined amount of oxygen; and the composite oxide is synthesized in a state in which the composite oxide contains a predetermined amount of an oxide of a third material that forms an oxide together with the alkali metal element.

33. The fuel cell according to claim 23, wherein the substrate is one of vanadium, niobium, tantalum, and an alloy containing at least a part of vanadium, niobium, and tantalum, and the electrolyte layer is disposed in such a way as to be closer to the hydrogen electrode than the substrate.

34. The fuel cell according to claim 23, wherein the electrolyte membrane is disposed so that at least one of the substrate and the coating is interposed between the electrolyte layer and the oxygen electrode.

35. A method of manufacturing an electrolyte membrane for a fuel cell, comprising the steps of:
forming a hydrated electrolyte layer that contains moisture; and
forming dense layers made of a hydrogen permeable material on both sides of the electrolyte layer.

36. A method of manufacturing an electrolyte membrane for a fuel cell, comprising the steps of:

preparing a substrate formed from a dense hydrogen permeable material; and

forming an inorganic electrolyte layer on at least one side of the substrate.

5

37. The method of manufacturing an electrolyte membrane according to claim 36, further comprising the step of:

synthesizing a composite oxide, which contains a constant molar ratio of an A-site material having an alkali metal element as a principal component and a B-site material having another element as a principal component, and which also contains a predetermined amount of oxygen, in a state in which the molar ratio of the A-site component to the B-site component is smaller than the constant ratio.

10

38. The method of manufacturing an electrolyte membrane according to claim 36, further comprising the step of:

synthesizing a composite oxide, which contains a constant molar ratio of an A-site material having an alkali metal element as a principal component and a B-site material having another element as a principal component, and also contains a predetermined amount of oxygen, in a state in which the composite oxide contains a predetermined amount of an oxide of a third material that forms an oxide together with the alkali metal element.

20

39. A method of manufacturing a fuel cell, comprising the steps of:
forming an electrolyte membrane by forming a dense layer of a hydrogen permeable material on both surfaces of a hydrated electrolyte layer containing moisture ;

25

arranging an oxygen electrode and an oxidizing gas supply portion that supplies oxidizing gas to the oxygen electrode on one side of the electrolyte membrane; and

30

arranging a hydrogen electrode and a fuel gas supply portion that supplies a hydrogen-rich fuel gas to the hydrogen electrode on the other side of the electrolyte membrane.

40. A method of manufacturing a fuel cell comprising the steps of:

forming an electrolyte membrane by forming a substrate formed from a dense hydrogen permeable material, and forming an inorganic electrolyte layer on at least one side of the substrate;

5 arranging an oxygen electrode and an oxidizing gas supply portion that supplies an oxidizing gas to the oxygen electrode on one side of the electrolyte membrane; and

 arranging a hydrogen electrode and a fuel gas supply portion that supplies a hydrogen-rich fuel gas to the hydrogen electrode on the other side of the
10 electrolyte membrane.